

Motor function of the spinal cord

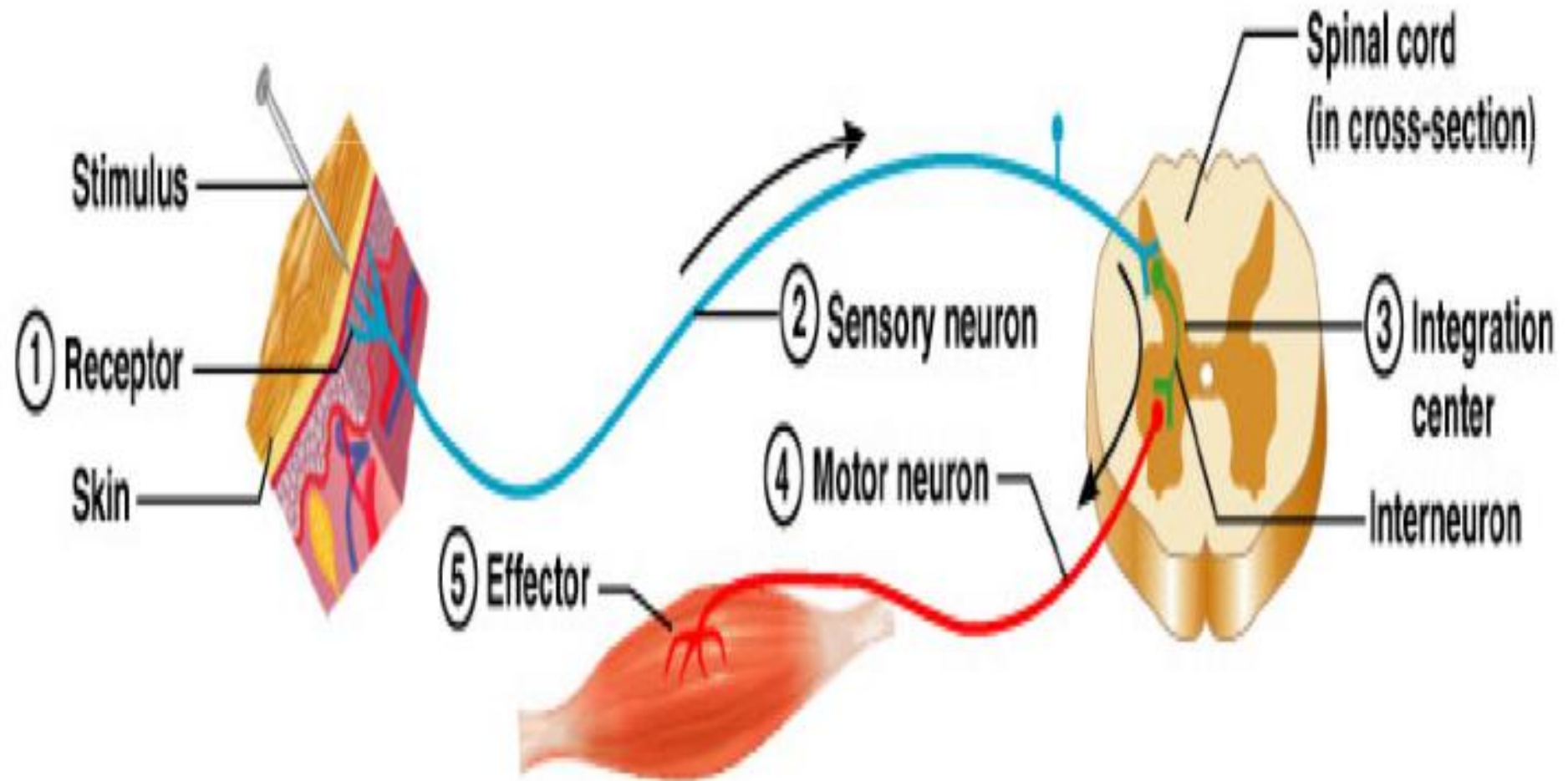
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Introduction

- Spinal cord reflexes enhance the ability of motor control system to produce coordinated movement
- Reflex is an automatic response to stimulus
- Components :
 - receptor
 - afferent pathway (sensory neuron)
 - integrating center (spinal cord or brain)
 - efferent pathway (motor or secretory neuron)
 - effector (gland or muscle)

Reflex arc



Classification of the reflexes

■ According to site of receptor

1. Superficial : withdrawal reflex , planter, abd
2. Deep : stretch reflex , Golgi tendon reflex
3. Visceral : micturition , defecation

■ According to number of synapses

- monosynaptic ; stretch reflex
- bi synaptic : Golgi tendon
- poly synaptic ; withdrawal

- According to the site of integration
 - simple (spinal cord)
 - complex (brain stem ,cortex)

Spinal reflexes

1. Deep reflexes (receptors in the muscles and tendons)

- * stretch reflex
- * golgi tendon reflex
- * postural spinal reflexes

2. Superficial reflexes (receptors in the skin)

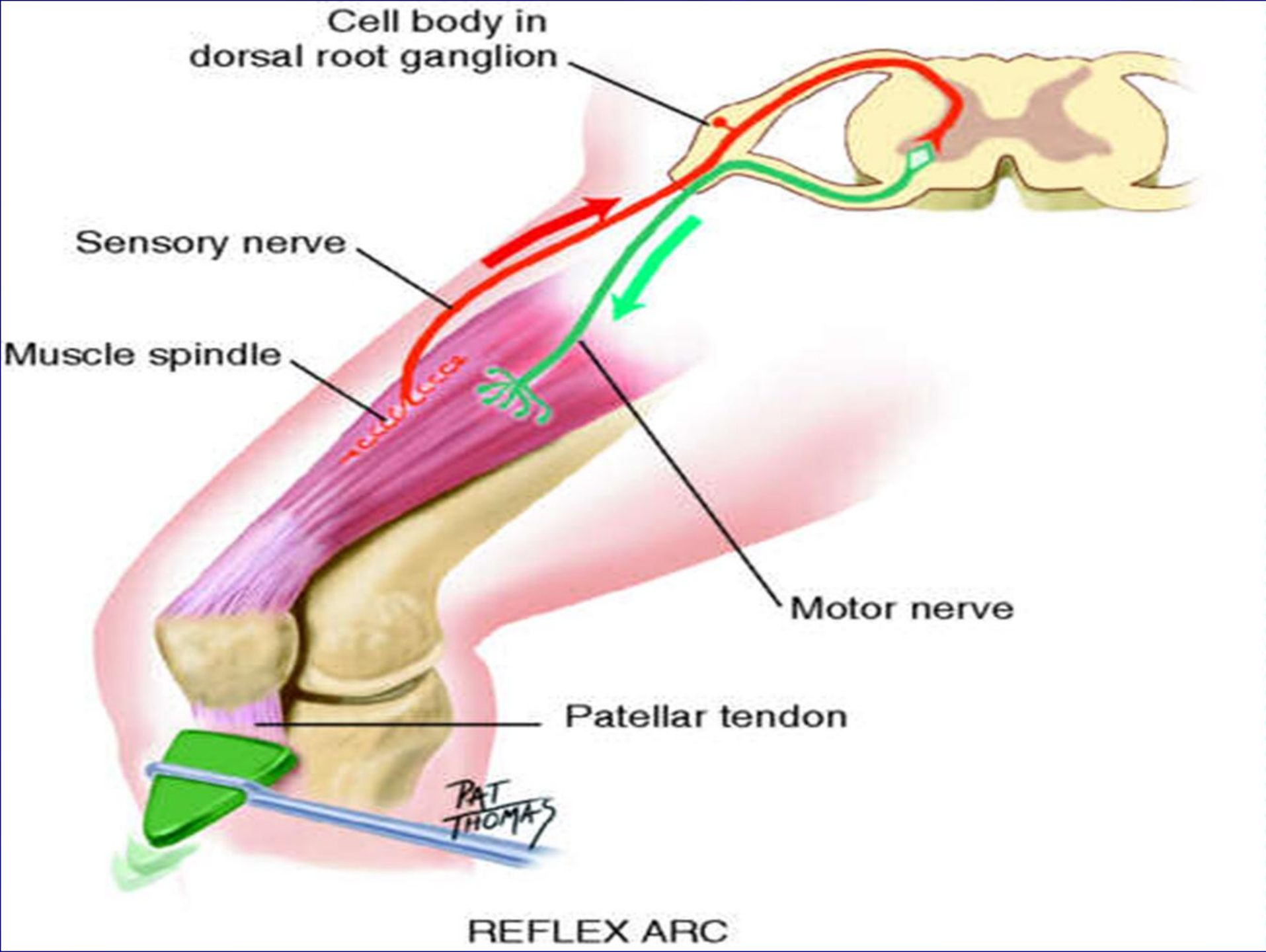
- * abdominal reflexes
- * cremasteric reflex
- * planter reflex

3. Visceral reflexes

- * micturition reflex
- * defecation reflex
- * erection reflex

stretch reflex

- Simple ,deep ,monosynaptic reflex
- It is the contraction (response) of the skeletal muscle, preceded by stretch (stimulus)
- Ex; knee jerk ,when patellar tendon is tapped by reflex hammer ,it stretches the quadriceps muscle ,which is contracted reflexively
- The receptor is muscle spindle



Receptor (muscle spindle)

- Spindle shape, encapsulated muscle fibers (intrafusal fibers), have sensory & motor innervation
- Arrange parallel with the main muscle fibers (Extrafusal fibers) generate tension
- Have 2 types :
 - A) 1)Nuclear bag fibers ;
-30 μ m in diameter ,7mm length

nuclei gathered centrally as if in a bag

- 2-3 nuclear bag fibers present in a typical spindle

- 2 types:

- 1- Dynamic

- 2- Static

2) Nuclear chain fibers : $15\mu\text{m}$ in diameter ,4mm length

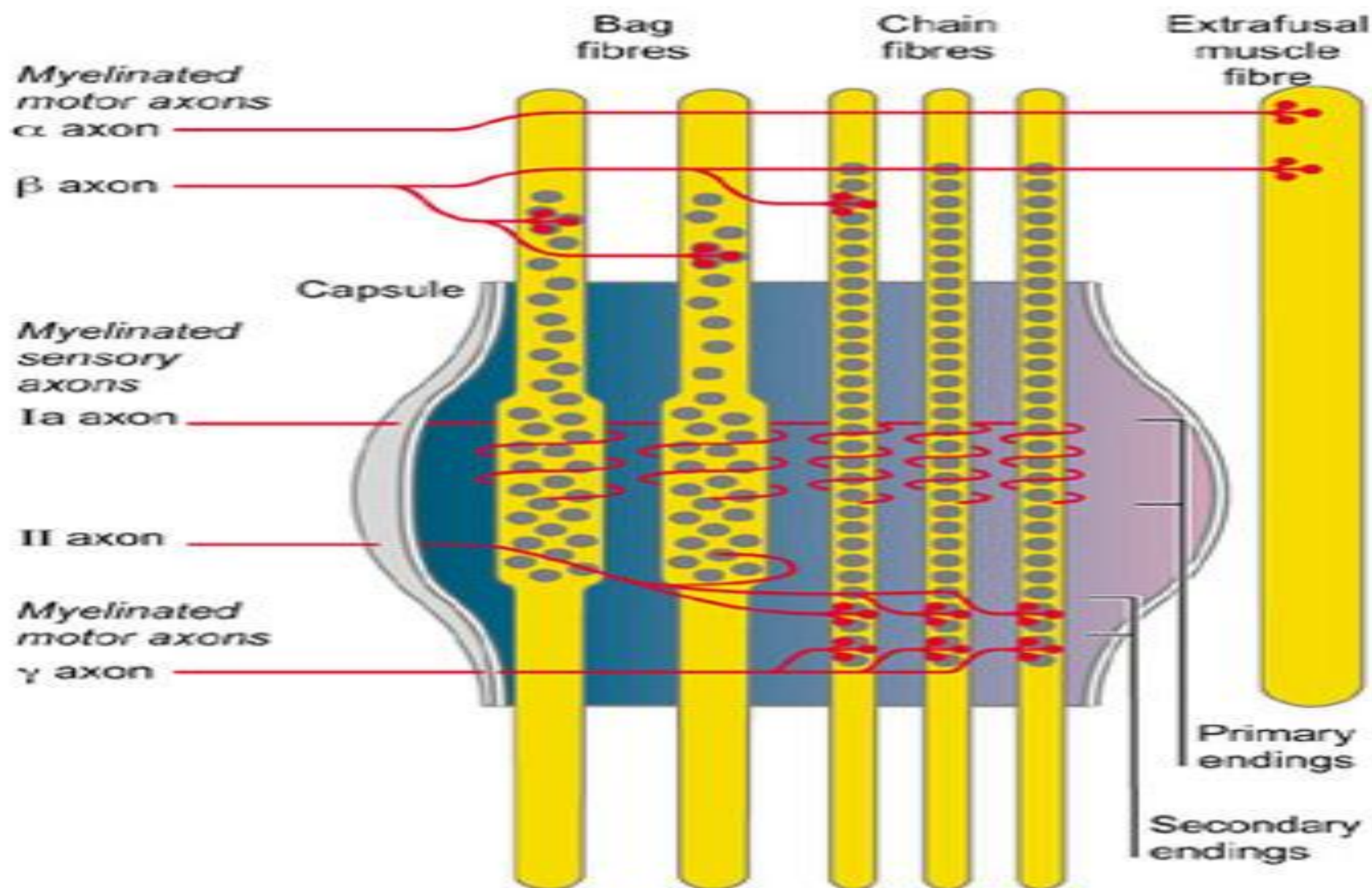
- nuclei lined up in single chain centrally

- 6 -10 nuclear chain fiber present in each spindle

- The connective tissue surround the intrafusal fibers continuous with that of extrafusal ,so both contract & stretch together

- Afferents attach to central part which is sensitive to stretch

- efferents attach to the end which are contractile



Stimuli of the muscle spindle

- 1) Extrafusal fibers stretch that lead to stretch of the central part of the intrafusal fibers by either gravity or tapping a muscle
- 2) Contraction of intrafusal fibers ends carried by γ efferent discharge

Afferent sensory neuron

- 2 types emerge from the spindle

1. Type (1a) fiber : 1ry sensory fiber

- single large myelinated fiber ,rapidly conducting
- wrap around nuclear bag (static and dynamic)& nuclear chain fibers, to form (annulospirl endings)

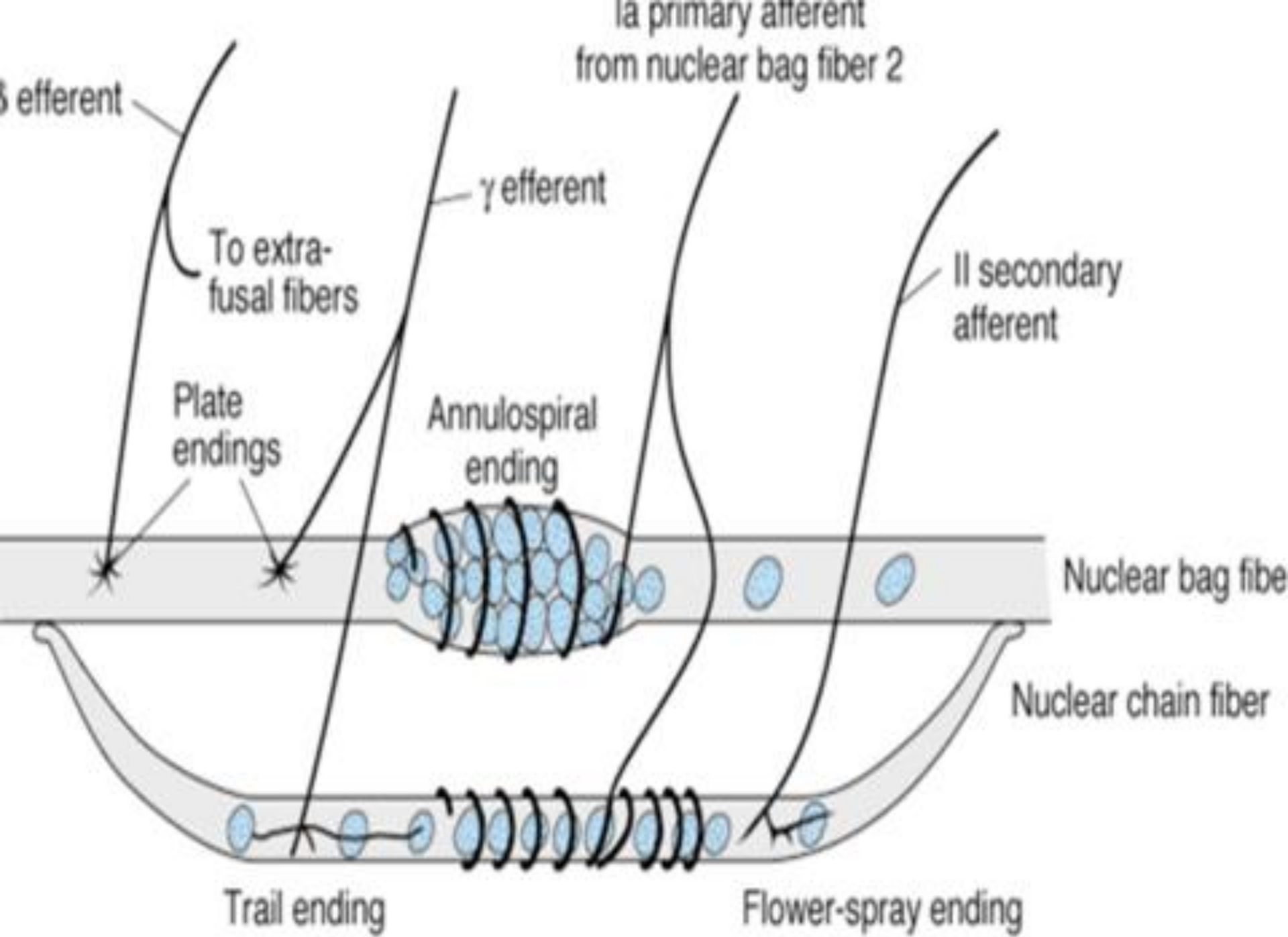
Provides information about the rate of change in muscle length (dynamic) and change in muscle length (static)

Afferents

2. Type 2: 2ry sensory endings

- have lower conduction velocity than type 1a
- _wrap only on static nuclear bag and nuclear chain fibers to form (flower spray endings)

Provides information about the change in muscle length (static)



■ Information carried by 1ry afferents

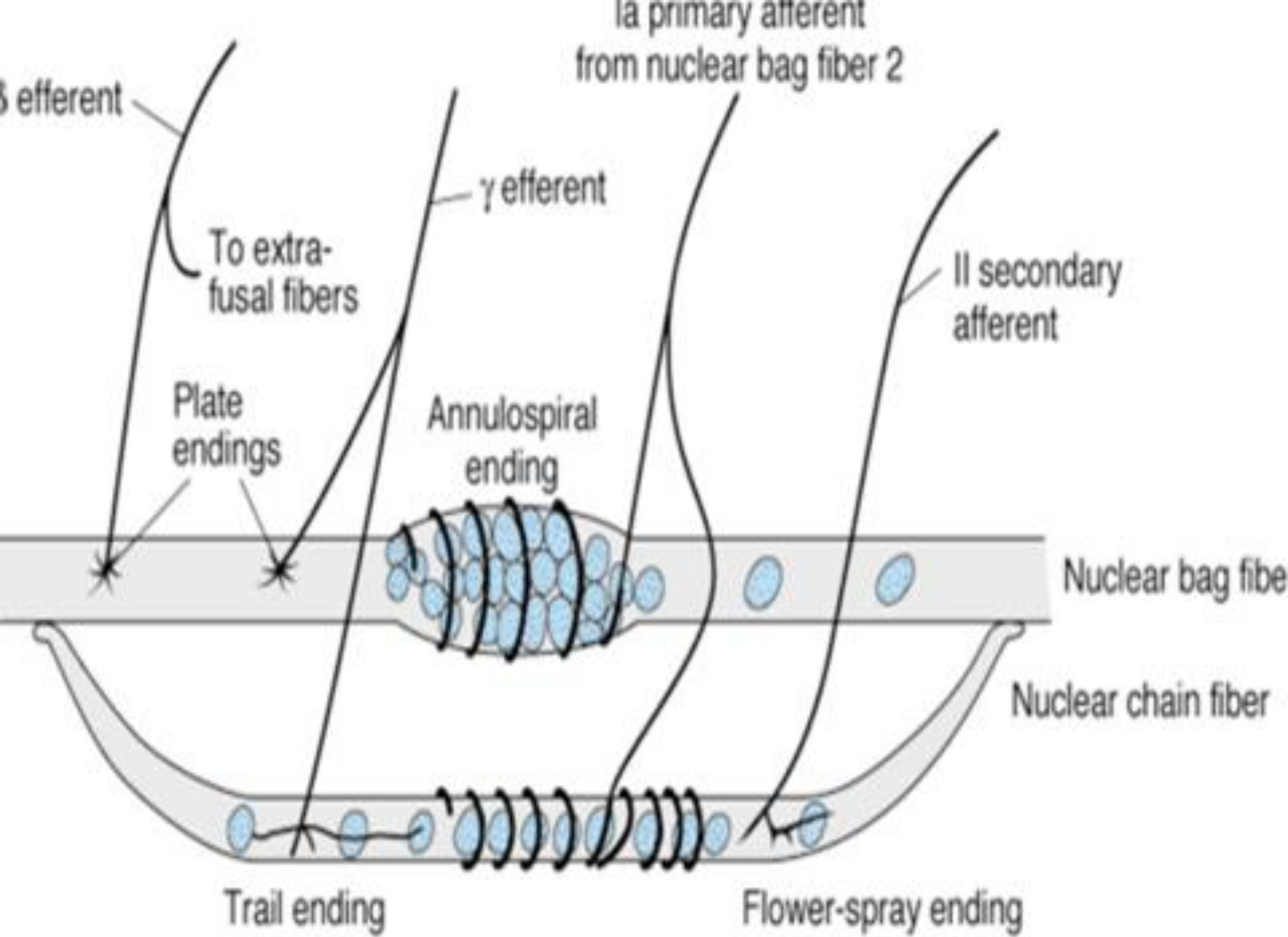
- dynamic** ;rapid discharge during muscle stretch , comes from nuclear bag , it measure the rate of change in muscle stretch
- static** : less rapid discharge during sustain stretch comes from nuclear chain and static nuclear bag , measure the muscle length

The center

- Afferents enter the spinal cord through dorsal root , either synapse with
 - efferent neuron ,the neurotransmitter is glutamate
 - interneuron , the neurotransmitter is glycine

Efferents

- 1) $A\alpha$: supply the extrafusal fiber to do muscle contraction
- 2) $A\gamma$: supply the intrafusal fibers , contractile part to $\uparrow$ there receptor sensitivity to stretch & generate muscle tone, 2 types
 - dynamic γ fibers ; innervate dynamic nuclear bag sensitivity of 1a afferent to stretch (plate ending)
 - static : innervate nuclear chain & and static nuclear bag $\uparrow$ tonic activity in 1a afferents at any given muscle length (trail ending)



Mechanism of stretch reflex

- When spindle is stretched ,sensory endings are distorted & Receptor potential generate all-or-non AP in afferent nerve
- The number of the AP proportionate to the size of the generator potential
- In the center the response graded in terms of EPSP & IPSP at the synaptic junction

- All-or-non responses are generated in the efferent nerve
- On arrival of the AP to the skeletal muscle again set up graded response which is always adequate to produce AP that bring about contraction

